Thank you.

I am very glad to be here today to share with you an exciting new technology thrust that we call   Structural Amorphous Metals or SAM.

Structural Amorphous Metals represent a new class of materials with multiple compelling and revolutionary applications.

Our initiative capitalizes on recent discoveries which have enabled the formation of amorphous metals in technologically important volumes.

We project that structural amorphous metals will have a significant impact on DoD capability and we are dedicated to developing and demonstrating this technology in a variety of important applications.

As a metallurgist, I would like to take a minute to remind you of the importance of metals to mankind.

Since the Bronze Age man has used metals to great benefit by exploiting their many desirable properties, for example strength, fracture toughness, conductivity and so on.

These properties arise as a result of the underlying MICROSTRUCTURE.

This microstructure evolves from the collections of crystallites (or grains) that make up the metal and are separated by grain boundaries.

Within the crystallites atoms are arranged in a periodic and ordered manner governed by the "physics of the system" and translating into specific space- filling arrangements.

The diversity of microstructure -- in terms of composition, morphology, orientation, defect content, etc. -- that can be achieved is immense.

This has resulted in literally hundreds of metal alloy systems that are currently used in virtually all technologically significant applications.

Unlike the metals that man has known and used for the last 4000 years, Amorphous metals are not made up of crystallites.

They do not have long-range order.

They have no grain boundaries.

As such they exhibit behaviors and properties that cannot be described or explained by the understanding, theories and models developed previously.

The atomic arrangement of amorphous metals is illustrated in the micrograph that shows the "random" packing of atoms... (right side of picture... in comparison to the ordered conventional metal structure... (left side of picture).

This fundamental difference between what was previously known and what is now possible provides the opportunity to break from the constraints imposed by the crystalline nature of conventional metals.

Therefore amorphous metals represent a new class of metals with unexplored potential... and pitfalls!!

The significance of these materials can only be appreciated when one considers that they truly represent a different paradigm in metal structure.

To illustrate this it is useful to consider the following.

A metal can be considered as being made up of two fundamentally different "components": a crystalline phase (the grains) and an amorphous phase (the grain boundaries).

Throughout the history of the development of metals, metallurgists have controlled the relative fractions of these components by varying the grain size.

For example, single crystal alloys (with no grain boundaries and hence zero volume fraction of amorphous phase) have been developed for electronic applications and high temperature turbine blades.

Most recently, nano crystalline materials with large volume fraction of grain boundaries (and thus high volume fraction of amorphous content) have generated a tremendous amount of interest.

However ALL of these developments have been on a (Build Red Line) single trend line.

Unlike the case of conventional metals, amorphous metals are OUTSIDE this trend line; they have NO grains and are 100% amorphous, and lie in a totally different material domain.

The laws that govern the formation, microstructure and properties of amorphous metals are largely unknown.

Beyond the opportunities afforded by the unique structure of amorphous metals themselves, it is interesting to consider the benefits that may accrue as a result of the (Build Yellow Lines One by One) transformation of amorphous metals to semi- or wholly- crystalline systems.

The pathways of this transformation offer yet another important tool for the microstructural evolution of the new alloys that can be used to provide unique and useful properties.

I would like to share with you why we are excited by this class of materials.

The combinations of properties achieved by amorphous metals are unlike those exhibited by conventional metals.

As the chart illustrates it is possible to achieve both high strength and very high resistance to fracture in the same material.

Such combinations of properties are not found in conventional materials where one often trades one property for another.

In addition, whereas conventional metals generally show decreasing fracture toughness (damage tolerance) with increasing loading rate, Amorphous metals appear to show INCREASED fracture toughness with increasing loading rate. This could have significant implications in areas where blast protection is required.

Numerous other potential applications are possible if these trends are verified at the large scale.

Also interesting to consider is the fact that the absence of grain boundaries within amorphous metals offer the possibility that localized corrosion phenomena, for example pitting corrosion, stress corrosion cracking, etc., will be significantly reduced as compared to conventional metals.

They simply do not have the discontinuities which can lead to crack initiation.

Coatings of amorphous metals, which can be applied by any number of techniques including plasma spray, may offer corrosion protection to large and small structures alike.

Combined with their high hardness, these coatings may offer substantial benefits in many marine or other corrosive environments.

Finally, amorphous metals exhibit self-sharpening behavior as a result of a process called shear localization.

This is a photograph of a rod of an amorphous metal following ballistic testing by CalTech scientists.

The importance of this photograph becomes apparent when one realizes that before testing the test rod was a right circular cylinder!!!!

Simply as a result of the loading it has self-sharpened.

The degree of shear localization which is responsible for this self-sharpening effect can be controlled by suitable processing to change the microstructure or by synthesizing composite architectures.

In closing, I would like to invite you to join us in discovering the mechanisms of structural amorphous metal formation, understanding the mechanisms of deformation and fracture, and identifying compelling applications for structural amorphous metals.

Details can be found on our website.

Thank you for you attention.